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AECB STAFF ANNUAL REPORT OF BRUCE NGS"B" FOR THE YEAR 1990

June 1991

Canada

Report

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1. Introduction

The Atomic Energy Control Board (AECB) is the federal nuclear regulatory agency. Its mission is "to ensure that the use of nuclear energy in Canada does not pose undue risk to health, safety, security and the environment". It exercises control through a regulatory system that establishes the health, safety, security and environmental standards for all uses of nuclear energy and licenses only those activities that can meet and maintain those standards. At all nuclear generating stations the AECB has resident staff who ensure that station operation is monitored and licensing conditions are enforced. This process requires that on-site project staff, in co-operation with AECB staff in Ottawa, monitors reactor operations, conducts audits and inspections, witnesses important activities, and reviews station documents and reports from the licensee.

A formal Annual Review Meeting is held with the station management and senior staff in order to discuss safety-related issues and to present to Ontario Hydro the AECB staff review of station operation during the year. This meeting is convened following the preparation, in draft form, of the AECB Staff Review of Station Operation. The report is compiled using, amongst other information, Ontario Hydro Quarterly Technical Reports. These are a requirement of the licence and summarize key features of station operation during the year. In addition to the Quarterly Reports, other Ontario Hydro reports, official correspondence, and observations of AECB site staff have been taken into consideration.

This report presents the AECB staff review of major licensing issues and of the operational performance of the station during 1990. The report is limited to those aspects of station performance that AECB staff considers to have safety significance. Where developments of significance, associated with issues addressed in the report, occurred in the early part of 1991, these are also mentioned.

2. Station Operation

Uprating from 890 MWe (megawatts electrical output) to 915 MWe was completed on Units 6 and 8 during 1990. Thus all four Bruce NGS"B" reactors now have a maximum continuous rating of 915 MWe.

The overall station capacity factor for 1990 was 80.5%. The lifetime capacity factor for the station at the end of 1990 was 84.1%. Individual unit capacity factors ranged from 73.2% (Unit 5) to 88.3% (Unit 7).

The following unit outages, of more than three days in length, occurred during the year:

Unit 5

90-02-10	Maintenance outage to repair a cracked section of boiler feedwater pump suction line (19.3 days)
90-08-15	Forced outage to repair moderator check valve (8.3 days)
90-10-16	Planned outage for turbine maintenance (58.5 days)

Unit 6

90-01-18	Forced outage to repair cracked section of boiler feedwater pump suction line (5.5 days)
90-01-31	Forced outage to repair a bleed condenser tube leak (9 days)
90-08-31	Planned outage to inspect steam generator tubes (39.7 days)

Unit 7

90-03-20	Maintenance outage to repair a cracked section of boiler feedwater pump suction line (7.6 days)
90-08-14	Planned outage to replace the bleed condenser tube bundle and to install new cobalt (16.4 days)

Unit 8

90-03-04	Maintenance outage to repair a cracked section of boiler feedwater pump suction line (15 days)
90-06-07	Planned outage for turbine maintenance and unit uprating (38.8 days)
90-10-11	Maintenance outage to repair main heat transport pump seals (4.5 days)

The number of outages during 1990 was higher than in past years. It is AECB staff opinion that these outages were necessary and that, in this regard, Ontario Hydro has operated the reactors prudently.

3. AECB Staff Review Of Operational Safety Aspects

3.1 Station Compliance

The operation of the station must comply with the Atomic Energy Control Regulations and the Physical Security Regulations. The Atomic Energy Control Regulations state that the operation of the station must be in accordance with the Operating Licence. Some of the licence conditions stipulate further documents which must be adhered to in the operation of the station. For example, the first licence condition states that the operation of the nuclear facility shall be governed by and be in accordance with the document entitled "Operating Policies and Principles" (OP&Ps) and the document entitled "Radiation Protection Regulations Part 1".

Following is a brief description of those events which occurred during 1990 which AECB staff consider to be in non-compliance with the Atomic Energy Control Regulations, the Physical Security Regulations or one of the licence conditions.

3.1.1 Compliance With The Atomic Energy Control Regulations

The normal fuel for CANDU reactors is natural uranium which is 0.7 percent of fissionable uranium, U-235. To achieve a desired neutron flux shape within the core, fuel depleted in U-235 is sometimes used. Depleted fuel used by Ontario Hydro is usually 0.4% U-235. Due to manufacturing difficulties, Ontario Hydro allowed Canadian General Electric to manufacture fuel bundles with 0.5% U-235. The stations were not notified that the depleted bundles were non-standard and subsequently these bundles were fuelled as though they were 0.4% U-235. A total of 34 non-standard bundles were fuelled at Bruce NGS"B", starting in 1985.

Part IV of the Atomic Energy Control Regulations defines requirements for record keeping and inspection of prescribed materials. The licensee must have records which show the nature, form and quantity of prescribed substances in his possession. In the above case, communications within Ontario Hydro broke down and the records at the station of the depleted fuel were inaccurate.

Fortunately, this event was of no safety consequence at Bruce NGS"B". However, had more of it been fuelled at once, reactor shutdown setpoints would not have been as effective as assumed in safety analyses or licence limits on channel or bundle power may have been exceeded. AECB staff considered this as a breakdown of record keeping and material control and demanded a full report from Ontario Hydro. An audit of Ontario Hydro's fuel accounting process is planned for 1991.

3.1.2 Compliance With The Physical Security Regulations

There were no breaches of the Physical Security Regulations at Bruce NGS"B" during 1990.

3.1.3 Compliance With The Licence

Ontario Hydro at Bruce NGS"B" was not in compliance with the licence when it issued a new revision to its document which describes the Station Organization and Responsibilities prior to receiving AECB approval. There was no significant change to the document but since it is referenced in the licence, prior AECB approval was required.

Section A.A.7 of the Operating Licence states that "The rate of release of prescribed substances from the nuclear facility shall be monitored...". In 1990 it was discovered that, during the second half of 1989, non-contaminated exhaust stack emissions were underestimated by a factor of two although the emissions were still below administrative limits. However, AECB staff is of the opinion that the cause of the error (the chemical work group being unaware of a change in the operation mode of exhaust fans) indicates a significant communications problem. On 90-02-22 it was discovered that this same requirement of the Operating Licence was being violated when it was found that the contents of the low radioactivity liquid waste storage tanks were being siphoned into the condenser cooling discharge duct (see Section 3.4).

Section A.A.4 of the licence states the requirements for radiation emergency procedures. These procedures include the requirement for site boundary dosimeters. During an emergency drill in June 1990 it was found that almost all the far boundary dosimeters were missing from their holders. In the event of an emergency these dosimeters are necessary to enable measurements of activity release from the station.

3.1.4 Compliance With The Operating Policies and Principles (Condition A.A.1 Of The Operating Licence)

There were two instances during 1990 in which a reactor unit emergency water system tank level dropped to a low level and was left low for many (>12) hours. Both these events constituted a breach of Section 71.2 of the OP&Ps which states that the emergency water system shall be operated and maintained to maximize availability. It is AECB staff's opinion that these events showed poor performance and a communications problem between the Unit 0 (the common systems "unit") operators who receive the tank low level alarms and the reactor unit operators.

Section 32.3 of the OP&Ps states that to ensure an effective ultimate heat sink for reactor fuel under certain accident conditions, the moderator system shall be operated such that the design degree of moderator subcooling (degrees below boiling) margin is maintained. The OP&Ps are breached if the moderator calandria outlet temperature exceeds a limit specified therein. There were four instances during 1990 in which the moderator calandria outlet temperature exceeded this temperature limit by a few degrees for a short period of time. AECB staff recognized that the violations of OP&Ps were not major ones but never-the-less is of the opinion that Ontario Hydro should investigate a means of better control of the moderator temperature or use a lower control setpoint so that the OP&Ps temperature limit is not exceeded.

There are four distinct classes of electrical power at the generating station. These are labelled Class I, II, III and IV. The classifications are categorized by reliability requirements - Class I power reliability requirements being the highest and Class IV reliability requirements are the lowest. Section 54.5 of the OP&Ps state that in order to maintain continuity of Class II power supplies, no more than one 120V bus per unit shall intentionally be supplied directly from Class III power. During a maintenance outage in Unit 8, two Class II buses were fed from Class III supplies. This unusual configuration was not recognized for over two days. It is AECB staff opinion that this event was one example of poor work control.

Section 54.2 of the OP&Ps defines the minimum number of standby generators which must be available (i.e. in standby state) for a given number of hot and pressurized reactor units. This section of the OP&Ps was breached when, on 90-06-18, all four standby generators were loaded to provide energy to the electrical grid. This was an oversight of the Shift Supervisor.

Section 21.1 of the OP&Ps discusses negative pressure containment system availability. Instances where this section of the OP&Ps were breached involved maintenance which impaired the containment activity monitors, and an incorrect setting of these monitors (see Section 3.6).

Section 1.6 of the OP&Ps discusses requirements for prior approval of the AECB to make changes to special safety systems. This requirement was breached once during 1990 when prior AECB approval was not sought when making a temporary change on shutdown system number two of Unit 5. This section of the OP&Ps also discusses the requirements for replacement components. This was violated when non-nuclear grade flanges were installed on Units 6,7 and 3. In AECB staff opinion, this was an example of poor material control.

Section 35.1 of the OP&Ps states the requirements for refuelling operations. This was violated when eight fuel bundles were inadvertently loaded into a channel in Unit 8 instead of four bundles shown on the fuel change order. AECB staff opinion is that this was a case of poor communications within the control room.

While non-compliancies with the OP&Ps may be caused by equipment failure, the majority of OP&Ps violations are caused by poor human performance. It is AECB staff opinion that the number (15) and the significance of the OP&Ps non-compliancies which occurred during 1990 indicate a clear need for improvement in human performance (for example, in communications in the control room and in awareness and attention to OP&Ps requirements).

3.2 Quarterly Reports

Quarterly technical reports for 1990 have been submitted by Ontario Hydro in a timely manner. These reports have been reviewed by AECB staff and were the source of much of the data for the table of Objective Measures in Appendix B. Ontario Hydro was responsive to AECB requests for the inclusion of additional information in the reports on stack compliance monitor and annulus gas system unavailability.

AECB staff concludes that the Bruce NGS"B" 1990 quarterly reports comprehensively and accurately record the 1990 station performance.

3.3 Radiation Protection

There were no exposures in excess of regulatory limits during 1990.

There was one event during 1990 which had the potential for causing a high exposure. A relatively high activity discrete particle was discovered on the sole of a plastic suit. Initial investigations identified three people who may have worn the suit. The final conclusions of the investigation assigned a dose of 7.5 rem to the left foot of one individual.

The positive changes in radiation protection at Bruce NGS"B" that were discussed as being planned in last year's annual report, took place during 1990. New and better monitors were placed in-service, better control over the regular submission of bioassay samples was established, and refresher training was completed by all staff.

With these changes in place, AECB staff considers radiation protection at Bruce NGS"B" to be generally satisfactory.

3.4 Station Effluent and Environmental Monitoring

Airborne and water borne emissions from the station were below one percent of the derived emission limits (DEL) during 1990. The Ontario Hydro Assessment of Environmental Radiological Data for 1990 concludes that the dose to the critical group (members of the public who might be most exposed to radiation) due to the operation of the Bruce reactors was .12% of the legal limit.

During 1989 AECB staff noted the high level of unavailability of the Bruce NGS"B" stack compliance monitors. Ontario Hydro was requested to record the performance of the monitors in its Quarterly Technical Reports. Ontario Hydro has complied with this request and with this increased attention, stack compliance monitor performance improved to an acceptable level during 1990.

On 90-02-22, siphoning was observed from the low activity liquid waste tanks to the condenser cooling water duct. It became apparent that the station had been discharging more radioactive liquid effluent to the environment (Lake Huron) than was being accounted for and that waterborne emissions were incorrectly reported for the period from August, 1988 to February, 1990. Releases for this period were still below one percent of the derived emission limits (DEL) when the releases due to the siphoning were considered.

AECB staff opinion is that station effluent discharges were acceptably low during 1990.

3.5 Process Systems

Adjuster Rods

Last year's Annual Report discussed the discrepancies which were found between the computer code, SORO, which is used to monitor reactor fuel power and the instrumented fuel channel power readings from Unit 6. It took Ontario Hydro some time to determine that the discrepancies were due to mis-positioned cobalt adjuster rods which were changed during the previous outage. As a result of this discovery, Ontario Hydro added some steps to its cobalt installation procedure to reduce the likelihood of mis-positioning during installation as well as improving the after-installation tests which verify that position.

AECB staff considered that the above event indicated that adjusters could be installed incorrectly, and that an incorrect installation could go undetected. However, with the new installation procedure, it seemed unlikely that the cobalt would be installed in the wrong position. It was therefore disturbing to AECB staff when Ontario Hydro reported that during the after-installation tests, adjuster rod 24 on Unit 7 was found to be in the wrong position. During the installation the cable from which the rod hangs slipped off its pulley and kinked. It was not satisfactory to find that the installation procedure was still flawed but encouraging to see that it was possible to detect the incorrect adjuster position. Ontario Hydro has since modified the cobalt installation procedure so that the adjuster cable is clamped into the pulley preventing it from slipping off.

Steam Generator Tubes

Last year's Annual Report discussed the fretted steam generator tubes which were found in Unit 6. During 1990 Ontario Hydro carried out further inspections in Units 5 and 8 and repeated inspections in Unit 6. From these inspections it has been determined that steam generator tube fretting (against their spacer bars) is generic to all Bruce NGS"B" steam generators. Fret growth rate has been predicted to be a maximum of 15% of tube wall thickness per year. The implications of these findings are discussed further in Section 4 of this report.

3.6 Performance of Special Safety Systems

The negative pressure containment (NPC) system did not achieve its unavailability target of 1×10^{-3} yr/yr in Units 5 and 6. In Unit 5 the NPC system activity monitors were impaired by cutting off flow past the monitors. In Unit 6, incorrect alarm settings on containment monitors resulted in an impairment to containment which lasted two months.

The other special safety systems met the unavailability targets during 1990.

The incorrect settings in the Unit 6 containment monitors were caused by control technicians relying on memory to set the monitors rather than checking the calibration cards. It is AECB staff's opinion that this is unacceptable performance for a control technician assigned to work on special safety

systems. Ontario Hydro intends to conduct a human performance investigation on this event.

3.7 Significant Events

Selected significant events are discussed in other sections of this report. This section discusses any trends which may be observed from considering all of the significant events which occurred at Bruce NGS "B" during 1990.

There were a total of 115 significant events during 1990, almost double the 64 there were in 1989. Thirty-five of these events (compared to 16 in 1989) were reportable under the Operating Licence. A list of the reportable events is provided in Appendix A.

The large increase in numbers of significant events is most likely due to the increased number of unit outages during 1990 compared to previous years. When the units are at power, with little other than routine maintenance being performed, there are fewer opportunities for error. An undesirable outcome of the increased number of significant events has been that Bruce NGS"B" staff was not able to keep pace with event follow-up during 1990. AECB staff will closely monitor significant event follow-up during 1991.

During 1990 there were 12 work protection related events at Bruce NGS"B", some of which had the potential for serious injury or death. The high number of work protection errors has been noted in past Annual Reports. It is apparent that work protection training at Bruce NGS"B" needs to be improved.

3.8 Quality Assurance

There was one AECB Quality Assurance (QA) audit at Bruce NGS"B" during 1990. During this audit two topics were followed-up from the previous audit: Control of Operating Memos and Safety and Relief Valve Testing. Although some improvements had been made in each of these areas, full compliance with procedures had not been achieved. A Quality Observation Directive was raised on the Control of Operating Memos and the previous Quality Observation Directive raised in regard to Safety and Relief Valve Testing was left open.

Other topics included in the audit were Safety System Testing, Chemical Control, and Material Control. A Quality Observation Directive was raised with regard to some non-compliancies in Material Control and one Quality Observation Recommendation was made with respect to ensuring requirements for Safety System Testing are clearly specified.

As discussed in last year's Annual Report, AECB staff and Ontario Hydro were in disagreement about the staffing of the Ontario Hydro Quality Assurance staff organization at the station. In order to address AECB criticism about this organization, Ontario Hydro increased the number and seniority of staff in the Quality Assurance Section. AECB staff considers this to be a major improvement. With its improved resources, the station QA group should now be capable of conducting more "in-depth" audits to more effectively assess the station QA program.

3.9 Station Maintenance

There continues to be evidence that standards of maintenance at Bruce NGS"B" are improving. The station management is committed to ensuring that the station is maintained to fulfill its function to permit "the safe production of electricity for 40 years". This commitment manifested itself during 1990 in the form of increased preventative maintenance on equipment and extension of outages for maintenance completion.

While the efforts being made at Bruce NGS"B" to maintain the station so that it achieves its purpose are commendable, it is AECB staff's opinion that Bruce NGS"B" staff is not yet adequately managing the work required to maintain the station. This can be seen from the large amount of outstanding deficiency repair work, the number of missed routine maintenance and the little progress that has been made in reducing the number of jumpers (see section 3 of Appendix B). The computerized work management system which is currently being introduced should help to improve the situation.

3.10 Chemistry

Overall chemical control performance at Bruce NGS"B" declined over 1990. The station does not meet its chemistry performance targets. The main reason given for this is a shortage of trained manpower, aggravated by the increased demand on manpower due to the requirements of the Municipal/Industrial Strategy for Abatement (MISA) program, which is a provincial program that requires extensive measurements of station effluents.

The AECB QA audit which took place during 1990 included chemical control as one of the topics. The auditors were encouraged by the efforts Ontario Hydro appears to be making to improve chemistry control. AECB staff's opinion is that the current chemistry control performance levels at Bruce NGS"B" will likely rise in future and if so, the present situation will not significantly impact on the safety of the station, since the effects of chemistry control on the system are long term.

3.11 Station Management

In the opinion of AECB staff, Bruce NGS"B" station management should be commended for the improvements which have been seen in the areas of maintenance, communications with the staff and safety culture (i.e., conservative operation of the station).

Communications with the staff have improved as a result of management initiatives such as a new station monthly newsletter and more frequent staff update meetings. Also, station objectives are clearly defined and publicized and the station performance (as measured by key performance indicators) against these objectives is posted in reception areas.

The most significant change has been in the improved safety culture. In last year's Annual Report, the concern was expressed that the reactors were not always operated in a conservative fashion when trying to recover from a transient or automatic shutdown (reactor trip). Bruce NGS"B" management

recognized this problem and made it clear to the operators that if a reactor state is not fully understood and known to be safe then it is to be shut down or held shut down. A new Station Policy was issued on the review of reactor trips which clearly defines what steps must be taken before resetting and restarting the reactor after a reactor trip. From discussions with the operators and shift supervisors, it is apparent to AECB staff that the station management has stressed to them the importance of conservative operation of the reactor and the requirement to comply with this new policy. This policy is being adopted at all Ontario Hydro stations.

Ontario Hydro Nuclear Generation Division has embarked on a Quality Improvement Program (QIP) which was created to improve the performance of its nuclear generating stations. The QIP Plan was issued in March of 1990 and thus far three Quarterly Reports have been issued. The Quarterly Reports provide summaries of results obtained and trends of performance indicators. So far there are many more initiatives (the output of many teams which have been formed to focus on particular areas for quality improvement) than there are visible results - but this is not unexpected for such a large and challenging program. Aside from the progress in the areas discussed above, Bruce NGS"B" has made progress in work management, radiation protection training and operating manual upgrading (but much more is still required in all these areas). AECB staff expects to see more results during 1991 now that the program has become established.

Deficiencies were identified in field operator performance at several Ontario Hydro stations. Lack of effective field supervision is believed to have contributed to performance deficiencies. To improve the quality of field supervision, a modified operator staff structure was developed. As required by the licence, Ontario Hydro has submitted its plans for this new organization to the AECB for approval before it is implemented. AECB staff is currently reviewing this proposal.

AECB staff has some concerns that there has not yet been any significant reduction of work backlogs. For example, in 1990 less than half of the planned equipment preventative maintenance program was accomplished and more than 800 jumpers (temporary changes) remained in place beyond their review date. Station management has not been successful in securing approval for the additional resources they consider necessary to reduce such backlogs to an acceptable level.

3.12 Training

Bruce NGS"B" staff who wrote AECB examinations in 1990 achieved passes at a rate of 82%. This is the same as in 1989. AECB staff considers these results to be satisfactory.

Radiation upgrade training was completed during 1990. Orange badge (first level radiation protection training) was upgraded to a half-day course. Results from a survey of radiation workers indicated that more frequent radiation protection refresher training is required. Workers (who are responsible for their own radiation protection) feel that they don't get enough practice in radiation protection on the job to maintain a knowledge of

what they learned in the class. This problem is currently being reviewed by Ontario Hydro.

Training for chemical technicians has been inadequate in the past at Bruce NGS"B". During the previously mentioned AECB audit, corrective actions were described.

3.13 Emergency Exercises and Drills

A summary of drills and exercises performed at Bruce NGS"B" during 1990 follows:

17 Off Site Survey Team Practices/Meetings
11 Radiation Emergency Drills
15 Conventional Safety Emergency Drills

This represents a 100% completion rate of planned drills for which Ontario Hydro is to be commended.

On 90-11-13, a full scale drill was held which involved fire and medical emergencies, as well as a radiation incident. This was to be a demonstration to the AECB of Ontario Hydro's ability to control and contain an accident of this nature. AECB staff were not satisfied with many aspects of the drill. This is discussed further in Section 4.

3.14 Security

During the period of July 24-26, AECB staff conducted a compliance inspection of physical protection measures at the Bruce Site. Security was found to be fully satisfactory and in compliance with the Physical Security Regulations.

There were three security events at Bruce NGS"B" during 1990.

There were two cases of an improper use of a turnstile entrance card. In both cases an employee allowed someone else to turn the entrance turnstiles using his card.

The other event involved a youth who had escaped from a detention centre becoming trapped between the outer chain link fence and the inner taut wire fence which surrounds the station. He was taken into custody.

AECB staff remain satisfied that security at Bruce NGS"B" is satisfactory.

3.15 AECB Staff Inspections

There are three types of AECB staff compliance inspections or activities: rounds, system inspections, and assessments.

"Rounds" form an organized and scheduled system of tours of the whole plant to see that everything is in order, e.g. radiation hazard signs are up to date, no water is leaking on to electrical equipment etc. Anomalies found are reported to the Shift Supervisor by memorandum.

There are sixty-eight rounds at Bruce NGS"B", roughly thirteen to each of the four reactors and central area. These were completed twice in 1990. The following are the most serious anomalies that were found and subsequently corrected.

1. Many instances in which the identification of system components of equipment was lacking and some in which it was incorrect.

2. A valve on the automatic poison addition system, a system that is part of the reactor regulating system, was found throttled on Unit 6 when the reactor was operating. This valve was not intended to provide a throttling function.

3. Miscellaneous items on the fire protection system such as two fire hydrant cabinets not installed at Unit 8, fire extinguishers past the date due for inspection, seals on fire extinguishers broken or missing, and hoses in fire hydrant cabinets full of water from passing valves.

4. Many status lamps on electrical equipment were burnt out and not replaced.

None of these findings, taken in isolation, are serious, but the many occurrences of missing component identification or burnt out status lights is indicative of a general malaise which should be corrected.

In system inspections, each safety-related system of the plant is examined to a depth commensurate with its importance to safety to see that it is operated and maintained properly and in accordance with station procedures. A brief report of the results is sent to the Production Manager.

Check lists for twenty-one systems at Bruce NGS"B" exist at present. Eleven systems were inspected at Bruce NGS"B" during 1990. Other than routine maintenance lagging behind schedule, they were found to be in a satisfactory state with one exception. Eight valves on various units on the shutdown cooling system were found unlocked whereas they are required to be locked. The missing locks were a procedural oversight which did not directly impact on safety since the valves were in their correct positions.

Assessments are made of plant operator activities to see that procedures are adhered to; examples are starting up a reactor after a long outage and work on pressure boundary repairs. A detailed report of the results is sent to the Station Manager.

There are currently six assessment plans prepared. One plan, reactor start-up after a long outage, was carried out on Unit 8 in July of 1990. The assessment determined that on the whole, the start-up was well done, despite being prolonged. The operators followed procedures closely and thought out the solutions to problems that arose in a careful and deliberate manner. However, there appeared to be some disorganization in work control with checklists, safety system test sheets, jumper records, deficiency reports and work packages spread haphazardly across the control room work-space. With

only broad plans in the control room, it appeared difficult for the first operators to determine the exact state of a system at any given time. Another deficiency that revealed itself was the shortage of assistant operators. Many of them were on vacation and operators that normally work exclusively on fuel handling systems were used to help with other reactor unit systems. Finally, verification of a system status, via checks against a system flowsheet after work had been completed on it, seemed random and at the discretion of the first operator or shift supervisor. This type of verification should have been built into the work planning process. AECB staff has forwarded a copy of its report of this assessment to Ontario Hydro and requested a response.

3.16 Measures of Station Performance

Measures of station performance are tabled in Appendix B. Many of these (including those which are rated as "needing action") have been discussed in other sections of this report. In general the list of measures of station performance show that Bruce NGS"B" was operated satisfactorily during 1990.

4. Significant Licensing Matters and Activities

4.1 Steam Generator Tube Fretting

As mentioned in Section 3.5, it has been determined that fretting of the steam generator tubes due to their vibrating against their supports is believed to be generic to all the steam generators at Bruce NGS"B". The steam generator tubes are a part of the pressure boundary of the primary coolant system and also part of the containment boundary. These tubes must not be allowed to weaken to the point that multiple tube failures could occur under accident conditions. Therefore, Ontario Hydro must be able to demonstrate that either the fretting process is "self limiting" and cannot result in tube failures or that they have designed and installed additional supports for the tubes to prevent further fretting from occurring. Alternatively, every tube that exceeds an acceptable limit on fretting depth must be removed from service. At the time of writing, Ontario Hydro is proceeding with a design change to prevent further fretting by adding additional tube supports and AECB staff is monitoring the program. It is expected that the modification will be installed on the first boiler in the fall of this (1991) year.

4.2 Firefighting Capability

It is AECB staff's view that Ontario Hydro, as part of its emergency preparedness, must have the capability to fight large fires at the same time as it is required to deal with a significant radiation hazard. This poses some special problems at the Bruce site where outside help may not be readily available. Ontario Hydro now has a plan in place to improve its firefighting capability at the Bruce site.

5. Conclusions

It is AECB staff's opinion that, overall, Bruce NGS"B" was operated in an acceptably safe manner during 1990. The more conservative attitude towards recovering the reactor from a trip or transient provides, in AECB staff view, a significant increase in the safety of the station. Bruce NGS"B" management is to be commended for establishing this attitude in the control room.

AECB staff is not satisfied by the increased efforts being made at Bruce NGS"B" in the areas of station maintenance, work management and communications. Improvement in these areas is necessary. It is apparent that the Ontario Hydro Quality Improvement Program started to make some impact at the station during 1990 but more visible signs of progress are expected during 1991.

AECB staff is concerned with the size of the backlog of work in the areas of preventative maintenance and documentation. To avoid deterioration of plant equipment state and operating standards as has occurred in the past at other CANDU stations, Ontario Hydro must take the necessary steps to reduce these backlogs to a safe and manageable level and to maintain them there.

Ontario Hydro still must demonstrate to the AECB staff that adequate firefighting capabilities exist at Bruce NGS"B" and at the Bruce site in general.

APPENDIX A

REPORTABLE SIGNIFICANT EVENTS

EVENT NUMBER	EVENT TITLE
B90- 06	Unit 6 Forced Outage Bleed Condenser Tube Leak
B90- 09	Airlock 2 - Breach of Containment
B90- 12	Potential for Level 2 Impairment of Containment
B90- 16	Work Protection Errors
B90- 17	Unplanned Discharge of Radioactive Effluent to CCW
B90- 18	Fuelling Machine Stuck on East Face of Reactor
B90- 23	Emergency Water System Impairment
B90- 24	SORO Input Errors
B90- 25	Containment Impairment
B90- 26	Unapproved Revision of a Document Referenced in the Reactor Operating Licence
B90- 27	Stepbacks on SDS2 Trip on Failure of Boiler LCV to Open on Transfer
B90- 28	Unrequested Reactor Power Change
B90- 29	Underestimation of Non-Contaminated Stack Emissions
B90- 32	High Activity Particle Detected on a Plastic Suit at Transfer Chamber 4
B90- 36	Approval Level for SDS2 Jumper
B90- 37	SDS1 Trip on PHT Pump Start-up
B90- 40	Far Boundary Thermoluminescent Dosimeters (TLDs) Missing
B90- 42	Too Many Standby Generators Running at Once
B90- 46	Breach of Containment - Error in Work Permitry
B90- 50	HT D_2O Leak Outside of Containment
B90- 51	Failure of Boiler Steam Relief Valve BSRV Actuators to Meet Test Requirements

B90- 54	Non-Contaminated Stack Tritium Monitor Failure
B90- 57	Level 2 Impairment Due to Incorrect Setting on Containment Monitors
B90- 58	Unit Shutdown Due to Moderator Flow Reduction
B90- 59	Draining of 7138-TK1
B90- 61	Incorrect Number of Bundles Fuelled into Channel V12
B90- 64	Moderator Temperature Transient
B90- 67	Unplanned Power Reduction and Flux Tilt Setback
B90- 76	Level I Impairment ECI
B90- 77	Unexplained Change in Zone Levels
B90- 78	Incorrect Flanges Used on Containment Penetrations
B90- 97	Breach of Containment
B90- 98	Stack Monitor Unavailability Exceeding Limit
B90-106	Use of Non-Standard Depleted Fuel Bundles
B90- 110	Unavailability of Inter-Unit Feedwater Tie Supply to Unit 5

APPENDIX B

OBJECTIVE MEASURES OF STATION PERFORMANCE
BRUCE NGS'B'

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
1.	**RADIATION CONTROL**			
1.1	**Occupational Safety**			
1.1.1	Total Whole Body Dose 1.85 Sv	1.65	✓	—
1.1.2	Total Extremity Dose 2.94 Sv	1.28	✓	—
1.1.3	Total Fuel Handling Extremity Dose 1.06 Sv	.437	✓	—
1.1.4	Total Neutron Dose 0.78 mSv	2.75	✓	—
1.1.5	Number of exposures > Regulatory Limits 0	0	✓	—
1.1.6	Number of radiation related supervisor's investigations 27	21	✓	—
1.2	**Public Safety**			
1.2.1	**Releases from the Station**			
	a) **Airborne**			
	Tritium No of weeks >1% DEL 0	0	✓	—
	Average % DEL for year 0.16 %	.079	✓	—
	Noble Gas No of weeks >1% DEL 0	0	✓	—
	Average % DEL for year 0.0060%	.038	✓	—
	Iodine 131 No of weeks >1% DEL 0	0	✓	—
	Average % DEL for year 0.0092%	.0016	✓	—
	Particulates No of weeks > 1% DEL 0	0	✓	—
	Average % DEL for year .0029%	.0032	✓	—

1.2.1 Continued		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
b) Waterborne				
Tritium	No of months > 1% DEL 0	0	✓	—
	Average % DEL for year 0.015 %	.063	✓	—
Gross $\beta\gamma$	No of months > 1% DEL 0	0	✓	—
	Average % DEL for year 0.017%	.030	✓	—
c) Total Heavy Water Loss	15 382 kg (if excessive, should be reflected in higher tritium releases)	19 988	✓	—
d) Critical Adult Dose	6.2 μSv	8.6	✓	—
1.2.2 Environmental Measurements				
Average Boundary dose rate	44.7 nGy/hr (Acceptable if within range of provincial reference sites value and not a significant increase from previous years)	37	✓	—
Average Boundary Tritium in Air	.032 % MPCa (> .1% MPCa would indicate a marked increase and would require investigation)	.052	✓	—
Average Tritium Concentration in Precipitation	295 Bq/l (average of all measurement sites)	484	✓	—
Average Gross β in Precipitation	41.8 $MGq/km^{-2}/mth$	36	✓	—
Average Tritium in Milk	26 Bq/l	32	✓	—

1.2.2 Continued

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
Average C14 in Milk	274 Bq/l	236	✓	—
Average I131 in Milk	0.15 Bq/l	.118	✓	—
Average Tritium in drinking water	22.5 Bq/l	37.5	✓	—
Average gross β in drinking water	.09 Bq/l	.118	✓	—
Local water and fish samples			✓	—

Specific items for comment:

none

Terrestrial Samples ✓ —

Specific items for comment:

none

2. Plant Control		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
2.1	Number of non-spurious Reactor Trips/Unit 1.0	1.75	No Comment	
2.2	Number of Serious Process Failures/Unit 0	0	✓	
2.3	Special Safety System Unavailability (10^{-3} Years/Year)			

	This Year				Last Year				Predicted Future		
Unit:	5	6	7	8	5	6	7	8			
SDS1	0	0	0	0	0	0	0	0	0.44	✓	
SDS2	0	0	0	0	0	0	.6	0.6	0.95	✓	
Containment	1.31	172.78	0.18	0.18	0	0	0	0	0.82		✓
ECI	<0.02	<0.02	<0.02	<0.02	<0.1	<0.1	<0.1	0	0.89	✓	

2.4	Number of Reportable Incidents/Unit 8.75	4		✓
2.5	Number of Fires 3	6	✓	
2.6	Number of Significant Human Errors Reported 21	11	✓	
2.7	Plant Capacity Factor 80.5 %	88.4%	not applicable	
2.8	% AECB Compliance Inspections "Unsatisfactory" 12.5 %	N/A		✓

		LAST YEAR'S VALUE	ACCEPTABLE	NEEDS ACTION
3.	Plant Maintenance			
3.1	Number of Unplanned Outages/Unit 3.3	2.25	No Comment	
3.2	Number of Call-ups Outstanding at year-end 1780	2710	___	✓
3.3	Average of Monthly Deficiency Reports Outstanding/Unit 1510	1049	___	✓
4.	Plant Administration			
4.1	Documentation			
4.1.1	Average No. of Operating Memos in force/unit on 31 December 60	65	___	✓
4.1.2	Number of Op. Memos extant > 6 months 34/unit	26/unit	___	✓
4.1.3	No. of systems (USI) with >1 Op Memo extant 6/unit	7/unit	___	✓
4.1.4	No. of Operating Memos behind schedule for review 9.5/unit	20/unit	___	✓
4.1.5	Total number of jumpers 1081	1043	___	✓
4.2	Training			
4.2.1	% Scheduled drills completed 100%	100%	✓	___
4.2.2	% Candidates passing AECB exams 82%	82%	✓	___
4.3	Security			
4.3.1	Number of reportable security events 3	3	✓	___

4.4 Quality Assurance

		ACCEPTABLE	NEEDS ACTION
4.4.1 Results of AECB Audits			
1) Date November 26-30	2 Directives - Operating Memos - Material Control 1 Recommendation - SSTs	✓	___